AD-A120 432 TRANSFER OF INFRARED AND VISIBLE RADIATION THROUGH CLOUDS OF FINITE HORIZONTAL AND VERTICAL EXTENT(U) WISCONSIN UNIV-MADISON J A WEINMAN OCT 82 1/1

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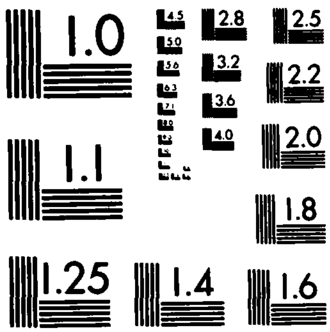

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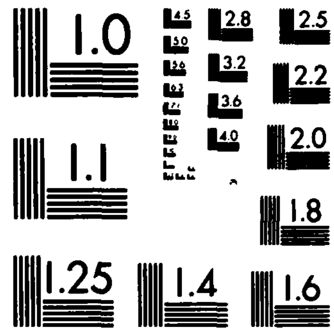

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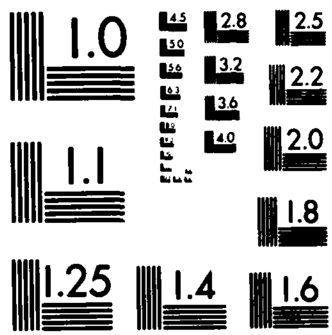

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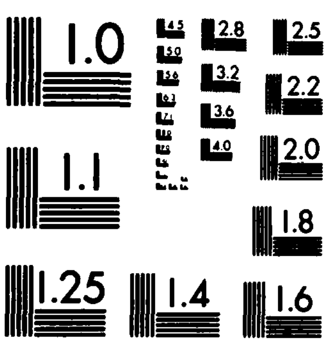

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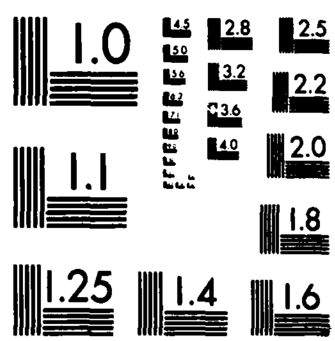

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18. SUPPLEMENTARY NOTES

The view, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

infrared radiation
light (visible radiation)
clouds (meteorology)
radiative transfer
mathematical models
remote sensing

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Grant DAAG29 78 G 0109 provided resources to investigate radiative transfer through non-stratified clouds. This study was addressed to the computation of solar and infrared flux and intensifies through horizontally finite clouds. The theory of these transfer processes was implemented by Monte Carlo techniques as well as by analytical models that could be rapidly implemented. Models developed under this grant will be applicable to models of climate and general circulation. The results of this study will also be applicable to remote sensing measurements obtained near turbulently dispersed smoke clouds.

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2. Foreward

Grant #DAAG 2978G0109 provided resources to investigate radiative transfer through non-stratified clouds. This study was addressed to the computation of solar and infrared flux and intensifies through horizontally finite clouds. The theory of these transfer processes was inplemented by Monte Carlo techniques as well as by analytical models that could be rapidly implemented.

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Statement of Problem and Significant Results

5. a-b

The work pursued with resources provided by grant #DAAG 2978G0109 achieved the following results.

The infrared radiation that could emerge from an isolated cuboidal cloud was computed by means of a rapid analytical technique. That method made it possible to compute fluxes and intensities that could emerge from such clouds. The effect of the sides on the radiative properties were illustrated. This variable azimuths two streams (VATS) theory was described by Harshvardrian, J.A. Weinman and R. Davies (1981). The theory was applied to a problem in remote sensing of surface features obscurred by smoke from brush fires in Weinman J. A., Harshvardhran and W.S. Olson (1981).

These studies showed that isolated finite clouds do not transfer radiation as black bodies and that significant radiation can pass through the sides of such clouds. In fact smoke clouds observed over typical brush fires are often transparent to 11 μm radiation so that imaging derives may be used to locate such fires even if they are obscurred by smoke. (This may not be true if steam smoke is thick).

Turbulence in the boundary layer causes arrays of finite clouds to form. Radiation that impinges on the side of such individual clouds may originate from the underlying surface as well as from neighboring clouds. The infrared fluxes and intensities emerging from idealized arrays of finite clouds were computed by a modification of the VATS technique. It became evident that geometric effects of cloud size and configuration were more important than the scattering or absorption characteristics of the particles that comprise the clouds, see Harshvardhan and Weinman (1982).

We also considered the effect of clouds on the transfer of solar radiation. The reflected intensity emerges from the parallel clouds can be rapidly calculated by an approximate technique developed by Davies (1980). That work was an outgrowth of an analysis of radiative transfer through isolated culoidal clouds. Cumulus clouds frequently occur in cloud arrays rather than as isolated entities. The fast analytical theory was adapted to the transfer of solar flux through an array of clouds, see Weinman, J.A. and Harshvardhan (1982). Interactions between cloud sides, side illumiation and shading were considered in those calculations. It was shown in that study as well as the earlier study on the infrared properties of cloud arrays that weighting of the albedo or emissivity of plane parallel clouds by the cloud fraction does not correctly describe those radiative characteristics for arrays of finite clouds. The theory developed in these studies is sufficiently simple so that those effects can be modeled without excessive effort.

5. c References

Journal Publications:

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Harshvardhan, J. A. Weinman (1982), Infrared Radiative Transfer Through a Regular Array of Culoidal Clouds J. Atm. Sci. 39, 431-439.

Davies, R. (1980), Fast Azimmthally Dependent Model of the Reflection of Solar Radiation by Plane Parallel Clouds, App. Opt. 19, 250-255.

Weinman, J.A., Harshvardhan (1982), Solar Reflection from a Regular Array of Horizontally Finite Clouds, App. Opt. 21, 2940-2944.

Conference Abstracts and Tech Reports.

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Weinman, J.A., Harshvardhan (1981), Infrared Radiative Tranfer through a Regular Array of Cuboidal Clouds. Fourth Conference of Atmospheric Radiation American Meteorological Society, June 16-18.

Weinman, J.A., Harshvardlan, W.S. Olson, (1981) 11.5 Micron Emission from Smoke Computed Using Finite Cloud Geometry. Winter meeting of American Society of Mechanical Engineering, Heat Transfer Divison, Nov. 16-21.

5. d Participating Scientists

J. A. Weinman, Prof. University of Wisconsin.
Harshvardran, Post-doctoral Scientist, University of Maryland
R. Davies, Post-doctral Scientist, University of Wisconsin (now Asst. Prof., Purdue University).
W.S. Olson, Graduate Student, University of Wisconsin (earned equivalent of MSc during program).
M. Masutani, Graduate Student, University of Wisconsin (transferred to other program).
J. Osinga, Graduate Student, University of Wisconsin and Utrecht University (earned equivalent of MSc during program).

6. See above.

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